

CIB050

Systems of performance based requirements for housing in Europe

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ABSTRACT

Most West-European countries call their regulations 'performance based' and the goals and major subjects are quite similar. A more detailed look at the formulation and content of the sets of requirements, however shows quite fundamental differences. The existence of the Construction Products Directive of the European Union and the development of Euro Codes did not have much impact on the harmonization of the technical building regulations at the level of buildings until now. Research into the differences in formulations is a first and important step towards better mutual understanding of national sets of building regulations which is essential to start a discussion of the possibilities of further harmonisation of the systems of the various countries. This paper presents the results and conclusions of a comparative study of the building regulations in Belgium, Denmark, England, France, Germany, the Netherlands, Norway and Sweden. The systems and formulations of the requirements and the contents of some subjects of requirements (for houses) have been compared in detail: stairways and ramps, fire safety, noise, daylight, accessibility and dimensions of habitable space and habitable room. We concluded that the broad spectrum of different systems forms a major barrier for further harmonisation of building regulations in Europe and even so a barrier for the realisation of an internal European Market.

Keywords: Building Regulations, Performance Requirements, Europe, Housing Quality CIB081

1 INTRODUCTION

The protection of safety and health of their citizens was the primary reason for West-European governments to draw up technical requirements and regulations for

the built environment. In the course of time other points of departure, such as utility, energy economy, sustainability and economic motives have come to play a part. Although the necessity of some set of public building regulations is undisputable, in the Netherlands, as well as in other countries, the scope, level and system are a constant subject of discussion since there is a permanent urge for deregulation. The administrative burden for all parties in the building sector caused by building regulations is the reason for a constant process of minimization and optimization of the building regulations in a way that they facilitate an effective and efficient building process. A reference to the scope, level and organisation of the building regulations in the neighbouring countries is considered to provide a good basis for this process.

The Dutch Ministry of Housing, Physical Planning and Environment commissioned a comparative study of the Building Regulations in eight European countries Belgium, Denmark, England and Wales, France, Germany, the Netherlands, Norway, and Sweden, focussed on technical requirements for dwellings and systems of implementation. The project resulted in two publications: Building Regulations in Europe Part 1, A comparison of the systems of building control in eight European countries (Meijer, Visscher and Sheridan 2002) and Building Regulations in Europe Part 2, A comparison of technical requirements in eight European Countries (Sheridan, Visscher, and Meijer 2003). This second study focussed besides the analyses of systems and overviews of the subjects in the regulations on a detailed comparison of the content of the requirements of some subjects. The study is based on a detailed analysis of both the formal documentation of building regulations and background literature about the systems of building regulations. A network of contacts supplied the necessary documentation for the countries concerned and advice on the translation and interpretation of the regulations. This article reflects on only some of the findings of part 2.

In this paper we describe the systems of formulation of the requirements and some of the findings of the comparison of content and level of the requirements. In section 2 of the article we describe the theoretical background of the differences in formulations of the building regulations. The Nordic Five Level System and the Performance System Model of CIB – TG 37 are used as basis for the analyses and prescriptions of the different systems. The analyses of the systems of the eight countries is described in section 3. In section 4 we present some results of the comparison of the content and level of the requirements. This is followed by the discussion in section 5 and conclusions in section 6.

2. SYSTEMS OF REQUIREMENTS

The formulation of technical requirements has been discussed for many years. For instance, the Building Research Station of the Department of the Environment in England conducted comparative analyses of building control from 1969-74 (Atkinson, 1974; Cibula, 1971; Cibula, 1970; Daldy, 1969; Honey, 1970). Daldy demonstrates that the move away from prescriptive specifications towards

functional requirements started over 30 years ago, offering a clear explanation of specifications, functional requirements, and performance standards, together with the use of deemed-to-satisfy clauses, codes of practice, the system of agrément, and information for guidance.

In 1978 the Nordic Committee on Building Regulations developed a five-level model of technical requirements (NKB, 1978). Almost 20 years later, Bowen compared this with the structure of the first version of the Dutch Building Decree (Bowen, 1997). The first three levels elaborate the objectives. Level one is a broad statement of what the building regulations are intended to provide, for instance: safety, health, energy conservation, accessibility, and protection of the environment. More unusually, they might provide safeguards against loss of amenity, or protect other property. Level two is a qualitative objective, specific to one aspect of the target performance, for instance: the building should be designed to provide opportunities to escape in case of fire. Level three is typically a qualitative or descriptive requirement, but in some countries, or for some aspects of performance, the operative requirements include quantitative requirements, for instance: an escape route should lead directly to open air (qualitative), and / or the distance between the door to a dwelling and a protected stairway should be no more than 15m (quantitative). The last two levels both deal with the interpretation of the objectives and requirements in practice. Level four identifies methods to verify compliance, for instance: distances on escape routes should be measured by way of the shortest route ignoring walls, partitions, fittings. Level five offers examples of compliance, for instance: a diagram showing requirements for means of escape for different corridor configurations. Often, level five is given in a supplement to the regulations, with examples of solutions deemed to satisfy the requirements (Bowen, 1997). The last two levels are sometimes combined because compliance with a given prescriptive solution is just one of several possible methods of verification (Foliente, 2000).

The CIB Taskgroup 37 'Performance based building regulatory systems' developed a model to analyse and describe the various systems of performance based requirements. In 2004 the Taskgroup held their final meeting at the CIB-world conference in Toronto and the final report was presented (Tubbs, 2004). The concept of the 'Performance System Model (PSM)' was formalized. The PSM moves on from the Nordic five level system, introducing a 'Performance risk level', which determines the application of requirements, and a further level of 'criteria' which can be worked out into objectives like health and safety, fire safety, structure, and sustainability. It also combines levels four and five into a single verification level, which includes design guides as well as testing or modelling techniques and can also refer to acceptable solutions.

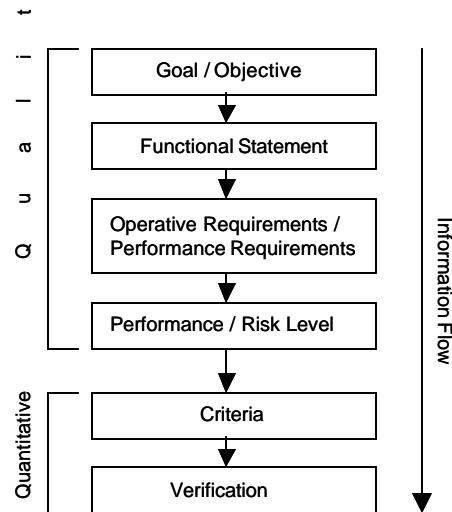


Figure 2: Performance system model CIB-TG 37

We have used this model to analyse the formulation of requirements in different countries. Some countries, including the Netherlands, have consciously attempted to follow such a model. Others have devised their own performance-based systems. Others continue to use traditional systems. The analysis is difficult, even for those countries that have adopted some form of performance-based system, firstly because commentators vary in their understanding of these terms, and secondly because there is inconsistency within the specific systems of regulations in the countries used for different subjects.

As other commentators have pointed out (Scholten, 2001; Beller et al., 2001) the term 'performance requirement' is interpreted in different ways. Although it is understood by CIB to mean the qualitative formulation of requirements or goals, as opposed to prescriptive regulations with mandatory design solutions, some countries understand it to constitute a description of desired levels of performance.

3. ANALYSES OF THE SYSTEMS

In The Netherlands the formulation of regulations in the Building Decree is the result of a deregulation program of the Dutch government in the nineteen-eighties which used some criteria: a regulation must be legally explicit and equitable, unambiguous and thereby measurable and verifiable, and a regulation should present only a minimal restriction on freedom and innovation in design. These criteria have been interpreted very strictly and led to a system of performance requirements that conforms to the CIB-TG 37 model. The goal is given in the Housing Law where it is stated that in the Building Decree regulations can be formulated relating to the building of constructions from the point of view of

safety, health, functionality, energy economy and the environment. Each performance requirement of the Building Decree comprises: a functional statement, which expresses the intention of the performance requirement; operative requirements which elaborate the practical implications of the functional description, often including: a limit value, which indicates the minimum level of performance that must be attained; a determination / verification method, usually by reference to a standard of the Dutch Standardisation Institute (NEN) or a Ministerial Regulation. The explanatory notes to the Building Decree also refer to certificates declaring the quality of materials or products, 'Kwaliteitsverklaring', which may be used to prove that they meet the levels of performance required by the Decree. Quality certificates are a form of verification. The Building Decree does not accord any special status to design guidance. In some cases codes of practice (NPRs) can be helpful.

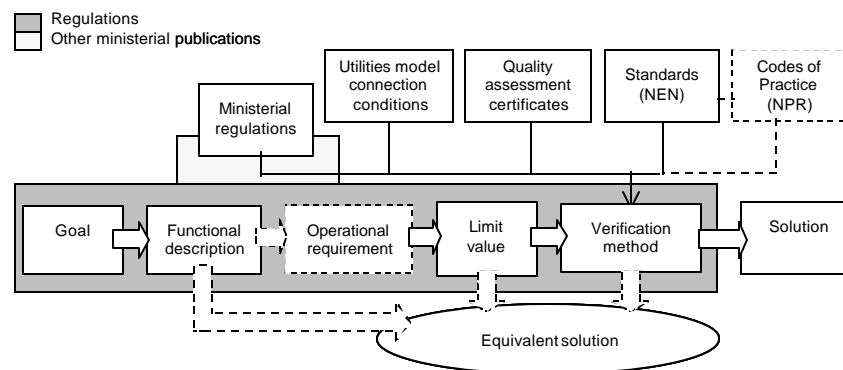


Figure 2: The Dutch Building Decree

The Building Decree does not offer examples of acceptable solutions. Its formulation, using performance requirements, is intended to allow a high degree of design freedom and to stimulate innovation. The Decree allows 'equivalent solutions' if a proposal does not meet one or more operative requirements, due to the use of innovative materials or construction techniques. In such cases, the developer must demonstrate that the proposed solution meets the intention of the functional requirement and the level of performance described by the limit value or determination method. In practice, although the formulation of the Building Decree appears relatively liberal, there are numerous examples of prescription, such as limitations on dimensions of stairways, to which it would be difficult to propose equivalent solutions. The formulation of the Dutch Building Decree and its relationship to other documents is described in Figure 2. In 2003 a revision of the Decree was introduced (Scholten, 2004).

In England and Wales, the structure of the Building Act, the Building Regulations, and the associated advisory Approved Documents is relatively clear, in terms of a

hierarchy of components. However, there are some inconsistencies between different subjects, which are partly the result of a rolling programme of review and amendment, but also reflect the nature of the subjects. The Building Act 1984 is the enabling legislation for the Building Regulations 2000. It gives the Secretary of State powers to make regulations for the purpose of: “a) securing the health, safety, welfare and convenience of persons in or about buildings and of others who may be affected by buildings or matters connected with buildings; b) furthering the conservation of fuel and power; c) preventing waste, undue consumption, misuse or contamination of water.” Schedule 1 to the Building Regulations sets out functional requirements, grouped in themes, termed ‘Parts’. Each functional requirement is brief, for instance: B1 Means of warning and escape: “The building shall be designed and constructed so that there are appropriate provisions for the early warning of fire, and appropriate means of escape in case of fire from the building to a place of safety outside the building capable of being safely and effectively used at all material times.” Approved Documents (ADs) are issued for each of the themes, which elaborate the requirements, discuss the underlying issues, and describe strategies that can be used to comply with the functional requirements. The ADs include: guidance on operative strategies and tactics (advisory equivalent to operative requirements); and various forms of verification: description of methods of measurement and verification, often by reference to British Standards; direct examples of acceptable solutions, often by means of diagrams or tables of minimum or maximum dimensions or other values; or references to external design guidance. The guidance describes appropriate criteria for the interpretation of the functional requirements and represents acceptable solutions. Building control bodies can also accept alternative strategies and tactics, provided the developer demonstrates that they comply with the functional standards. The relationship of the Building Regulations, Approved Documents, and other documents is described in Figure 3.

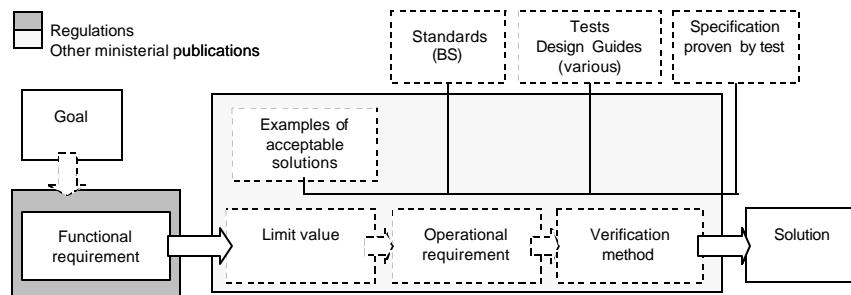


Figure 3: The Building Regulations of England and Wales

Unlike many other countries, *Belgium* has not reformulated traditional building regulations as performance requirements. The reason for this may be political, given Belgium’s federal nature, without uniformity of technical regulations, on either a national or regional basis. The clearest control is the national legislation for fire safety, which is arranged in terms of risk classes related to fire-fighting

equipment, and does not apply to single family houses. Most of the requirements are written in a prescriptive manner.

In *Denmark*, the Building Act 1993 is implemented in the Building Regulations and the Building Regulations for Small Dwellings. There is no clear statement of goals in the Building Regulations; presumably this is given in the Building Act. There is some resemblance to the CIB-TG 37 model, but the distinction between functional statements, operative requirements, and guidance is inconsistent. Mostly, both sets of building regulations use mandatory functional statements, accompanied by optional interpretations (the advisory equivalent to operative requirements). Some of the interpretations comprise references to standards and codes of practice.

In *France*, only the more recent regulations, such as those for acoustic performance, are written as performance requirements, and despite a hierarchy of regulation and guidance there is little resemblance to the CIB-TG 37 model. The building and housing code comprises legislative articles and regulatory articles. There is no overall statement of goals. The legislative articles allow regulations to be made by Decrees of the Council of State, identify the subject of regulations, and specify the application of requirements. Some legislative articles refer to Laws. The regulatory articles are a mixture of specifications and performance requirements. Many regulations require implementing orders to be made to set levels of requirements, but for some subjects (such as thermal performance) operative requirements are to be included in the same implementing order as verification methods. Some decrees (such as those for accessibility) are self-contained, detailed specifications of operational requirements, but for some subjects (such as fire safety), details are given in implementing orders.

The building regulations in the federal republic of *Germany* fall under the responsibility of the governments of the states. They are based on a central model: the Model Building Ordinance. In the project we explored the regulations of the state Hesse. In Hesse, the Building Ordinance is mostly written as performance requirements, but it has only limited resemblance to the CIB-TG 37 model, and it is inconsistent in its formulation. There is no overall statement of goals. The HBO requirements were re-formulated, with effect from 2002, as brief functional statements, indeed there are no further explicit requirements for some subjects (such as “sufficient sound insulation”). However, some subjects include operative requirements and specifications. There is no indication of the means of verification, but it is implicit that reference should be made to national standards. Performance risk level is reflected in the building classifications, given in both the text and annexes.

Since 1997 *Norway* has systematically adopted performance requirements in the Technical Regulations to which is referred in the Planning and Building Act of 14 June 1985 No. 77. The structure of the Technical Regulations and accompanying guidelines is broadly similar to the CIB-TG 37 model. The Technical Regulations

comprise functional statements. The Guidelines to the regulations are the advisory equivalent to operative requirements, but detailed interpretation relies on the Norwegian Building Research Institute's series of planning and technical information leaflets. The Guidelines refer to national standards, but the Byggforsk leaflets are commonly understood as acceptable solutions, and in practice constitute the main source of verification.

In *Sweden*, the Building Regulations implement provisions of the Planning and Building Act (1987:10). There is no overall statement of goals in the Building Regulations. The Building Regulations comprise mandatory provisions, which are mostly functional statements, and advisory 'general recommendations'. Most of the mandatory provisions are performance requirements (such as design for accessibility), but some include specifications or operative requirements (such as ceiling heights, and periods of fire resistance). General recommendations variously include examples of provision satisfying mandatory requirements (the advisory equivalent to operative requirements), references to various means of verification (including Swedish Standards and other sources), and definition of terms and clarifications of the meaning of mandatory requirements. The Building Regulations approve alternative methods and design solutions set out in European Standards adopted as Swedish Standards, and in European Prestandards. General recommendations may also contain certain explanatory or editorial information.

4. COMPARISON OF REQUIREMENTS

4.1 Stairways and ramps

The Netherlands has replaced some of its earlier very low standards for straight stairways, with increased minimum goings and reduced maximum rises. The standard for private stairs is now less steep than in England and Wales, but the standard for common stairs is still the steepest. The concomitant increase in the floor area needed for the stairway will probably encourage the already widespread use of private stairs with tapered treads, which are more common than in other countries. The changes for common stairs are also significant. However, the Building Decree perpetuates poor safety standards for the guarding of stairways and ramps. It compares unfavourably with requirements in most other countries for guarding to extend the full length of stairways and ramps, and for the height of guardings. Lighting has been identified as a contributing factor to accidents on stairs, but none of the building regulations studied countries addresses the issue of the daylighting or artificial lighting of stairways.

4.2 Fire safety

A harmonised European system to classify the reaction to fire of construction products was approved in 2002, but there is great diversity in the regulations of the studied countries in the description of fire safety strategies, classification of buildings, or description of parts of buildings. Mostly, fire safety strategies are similar if differently expressed, but there are some significant differences in levels of requirements. The Building Decree is unusual in its concepts of sub-fire and smoke compartments, its definition of permanent fire load density, and its control

of the smoke production of internal surfaces, but it is difficult to tell whether these create significant differences from other countries in practice. Although the description of compartmentation is different in the Netherlands, the strategy that each dwelling constitutes a compartment is similar to that in Denmark, England and Wales, Norway and Sweden. There are very few controls on single family housing, and there is no national or federal fire safety legislation for houses in Belgium. The greatest diversity in strategies lies in the provision of means of escape. Several countries allow rescue as a second route, and all allow a single escape route in various circumstances. The only absolute requirements for two independent escape routes for housing are for tall buildings in Belgium and Denmark. The issues of maximum travel distances, and the number and location of exits are common to most countries, but expressed quite differently and with varying levels of requirements. Each country limits characteristics of internal surfaces of escape routes, but only the Netherlands limits the rate of smoke production of surfaces. Only Denmark and England and Wales control internal surfaces of private areas of single family housing. The scope of requirements for external surfaces varies widely. None of the building regulations studied specifies materials or constructions deemed to satisfy the requirements. Each country refers to national standards for background information, but the Dutch Building Decree is unusually reliant on national standards for the interpretation of strategic issues and it is not possible to understand the scope of requirements from the main document alone.

4.3 Noise

Most countries specify levels of requirements within the Building Regulations or associated guidance documents, but Belgium, Germany (Hesse) and Sweden rely on recommendations in national standards. Despite reference to EN-ISO standards, there are important differences between countries in the criteria used to describe acoustic performance, including methods of measurement and the application of different reference curves or spectrum adaptation terms. Belgium and the Netherlands use indices that are not used in any of the other countries, but each is gradually adapting to EN-ISO 717. The varied acoustic criteria mean that it is difficult to compare requirements, but many of the differences are probably barely perceptible. The greatest differences are in levels of requirements for impact sound. Low frequency components of airborne sound often contribute to domestic noise nuisance but only England and Wales, France, and Sweden currently address this issue. The Netherlands is one of the few countries to require acoustic protection between spaces within the same dwelling. Otherwise, the scope of requirements is broadly similar, with the exception of England and Wales which lacks specific requirements regarding noise from equipment. Pre-completion testing of buildings is the most demanding and expensive implementation procedure but only Denmark and England and Wales require such testing. In practice, noise control must rely on the use of constructions that are known to satisfy the requirements, but this does not guarantee as-built performance. Even in England and Wales, the housebuilding industry is being given an opportunity to develop standard details as an alternative to testing. In future, EN 12354 may be

adopted as a way to justify the choice of construction. Noise control is a topic that is relatively impenetrable to non-experts, and it appears that the design standards are increasingly the domain of specialists.

4.4 Daylight

Daylight openings are regulated in each of the countries studied, except for England and Wales. However, the nature of requirements is relatively unsophisticated and would not necessarily provide an appropriate standard of daylighting. The requirements for the size of daylight openings are not directly comparable. Only Norway sets targets for the level of daylighting, rather than the size of openings. Only Denmark and Sweden address issues of sunlight. Daylighting is treated as a basic amenity in building regulations, but it might be more appropriate to link requirements with energy performance, so that design for daylighting could be seen as making a contribution to reductions in CO₂ emissions.

4.5 Accessibility

“Accessibility enables people to participate in the social and economic activities for which the built environment is intended.” (European Concept for Accessibility) There is striking divergence from the ECA, not only in terms of standards, but in the scope of accessibility legislation. The expression of requirements also varies, so that direct comparisons are not always possible. The Netherlands has generally lower standards of accessibility requirements than Sweden, Denmark, or England and Wales, and a lower standard for blocks of flats than France, or the DIN standard in Germany. The limited application of requirements, the lack of some requirements, and the form of expression of others mean that the Building Decree does not guarantee the accessibility or visitability of environments and dwellings. There are considerable differences in the application and levels of requirements. Overall, the highest standards should be generated by the performance requirements in Sweden, which constitute a nearly comprehensive accessibility and usability standard for dwellings on one storey and the entrance storey of other dwellings. None of the countries studied has particularly extensive standards of provision for people with visual impairments, and there is very little mention of the needs of people with other types of sensory impairment.

4.6 Dimensions of habitable space and habitable rooms

Floor area is a key determinant of amenity and accessibility, but space standards are no longer a central consideration of most European building regulations. The Netherlands has more extensive space standards and dimensional requirements for rooms than the other countries studied, but requirements for ceiling heights have been retained in each country except England and Wales. The Building Decree asserts that its requirements are necessary to ensure a functional design and it would be interesting to discover whether the working of the market achieves this in other countries. The removal of controls in England and Wales resulted in reduced space standards, but it is difficult to evaluate whether or not the designs are functional. It is also difficult to demonstrate whether the flexibility afforded by

higher space standards makes a significant contribution to the sustainability of housing development, but it seems sensible to protect the space standards of the housing stock by building regulations, rather than market forces.

5. DISCUSSION

Some remarks have to be made about the limitation of our findings due to the necessary limitation of the approach. We took the Dutch Building Decree as a point of departure. From there we analysed the equivalent regulation documents in the other countries. The focus was on national (or state) mandatory regulations. It might be possible that in the studied countries additional quality regulations on a municipal level via local bye-laws play a considerable role. The level of government regulations should further be considered in relation to (minimal) quality of the realized buildings and the existing private law quality regulations, instruments and quality assurance schemes. A next step in research on this issue would be to examine the effectiveness and efficiency of the sets of regulations in the various countries (see Visscher 2000). Such a project would have to stretch out from the formal regulations, the systems of building control, an investigation of other forms of regulations (public and private law) and the level of professionalism of the various actors in the building process, such as the principal, the architect, technical advisor and the construction firm. This is a very complex matter. A possible approach would be to focus such a research on a single topic that is issue of public building regulations in all countries, such as for instance fire safety. The effectiveness and efficiency of the regulations should then be examined at the hand of a few reference building plans. The project should monitor the way the regulations are implemented and controlled through the whole building process.

6. CONCLUSION

The Performance System Model of CIB TG 37 is useful to analyse the systems of building regulations. It is a useful tool to interpret and describe the systems. The countries studied use a broad variation of systems and formulations of the requirements. The numerous combinations include: generalised 'functional' requirements in combination with 'deemed-to-satisfy' practical design solutions; generalised 'functional' requirements with design guidance, or reference to external sources of design guidance; 'prescriptive' requirements with reference to solutions; and quantitative 'performance' requirements without reference to practical design solutions.

Apart from Belgium, there is a general trend towards performance-based requirements, but the concept of performance requirements is interpreted differently and in most of the countries the technical regulations include specifications. There is a common pattern of verification by reference to national standards, but some countries also refer to other sources. The practical implementation of technical regulations often relies on guidance that are not cited in regulations. The grouping of subjects is different. Despite the intentions underlying the revision of the Dutch Building Decree, England and Wales offers clearer distinctions between functional requirements and guidance, and conforms

more closely to a performance-based model. The system of formulation of the Dutch Building Decree is the most abstract approach of the performance concept among the countries that were involved in this study. Its structure emerged by strictly following the objectives that were set up for the new regulations. Reference to construction solutions were avoided as much as possible to stimulate innovation. How this has worked out in the building practice has never been evaluated as far as we know.

In the long term, one would hope that Model European Building Codes would evolve. Potential difficulties in international working caused by the lack of harmonisation were mirrored in the difficulties of the comparative analysis. This was particularly true of fire safety requirements for which, without a common framework of strategies and tactics it was difficult to confirm the absence of requirements, and without common terminology or criteria it was difficult to compare levels of requirements. Important issues for harmonisation include the classification of buildings and the description of parts of buildings, which are used to describe the application of for instance the fire safety requirements.

The prospective for further harmonisation of building regulations in Europe has two faces. On the one hand it could be argued that the differences in systems and formulations are too severe to expect further harmonisation on the European level. These differences result from different legislative and cultural backgrounds which reduce opportunities for harmonisation. Also, there is no urgent reason for further harmonisation of requirements at the level of buildings. Most building activities take place on a regional or national basis. In contrast, the development of energy labelling of buildings according to the European directive for energy performance, will in 2006 introduce energy performance regulations in all EU-countries that are very much harmonised. This fact may give a new impulse to more uniformity of systems of regulations in the EU.

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